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H4F FAAE FAAP FD12X FD27T1 FD30J FD30K

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INT CL[5] G06F 15/70 , H04N 5/232
Online:WPI

(54) Image Tracking Apparatus

(57) An imaging device such as a video camera 10 forms an image of a target such as a moving vehicle and produces images signals based on the formed image at a predetermined time interval, a first memory 5A stores the image signals, a window setting means sets a chasing/tracking window, (figure 2 not shown) on the stored image signals a predetermined time before and a second memory 6A stores, as reference image signals, the image signals on which the chasing window has been set. A disturbance detecting device detects whether or not any disturbance has been introduced into the image signals stored in the first memory (e.g. fig. 3 not shown) and a correcting device 12 corrects , by interpolation or similar technique, the image signals stored in the first memory to reduce the influence of any disturbance. A window updating device updates the chasing window in accordance with the result of comparison between the stored reference image signals and the stored image signals or, when a disturbance has been detected, in accordance with the result of comparison between the reference image signals and the image signals which have been corrected by the correcting means.

FIG. 1

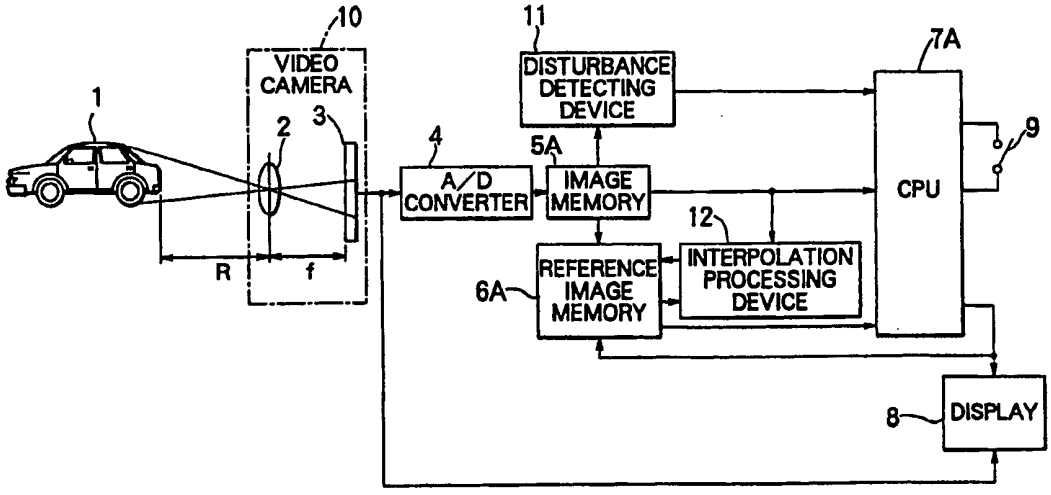

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FIG. 1

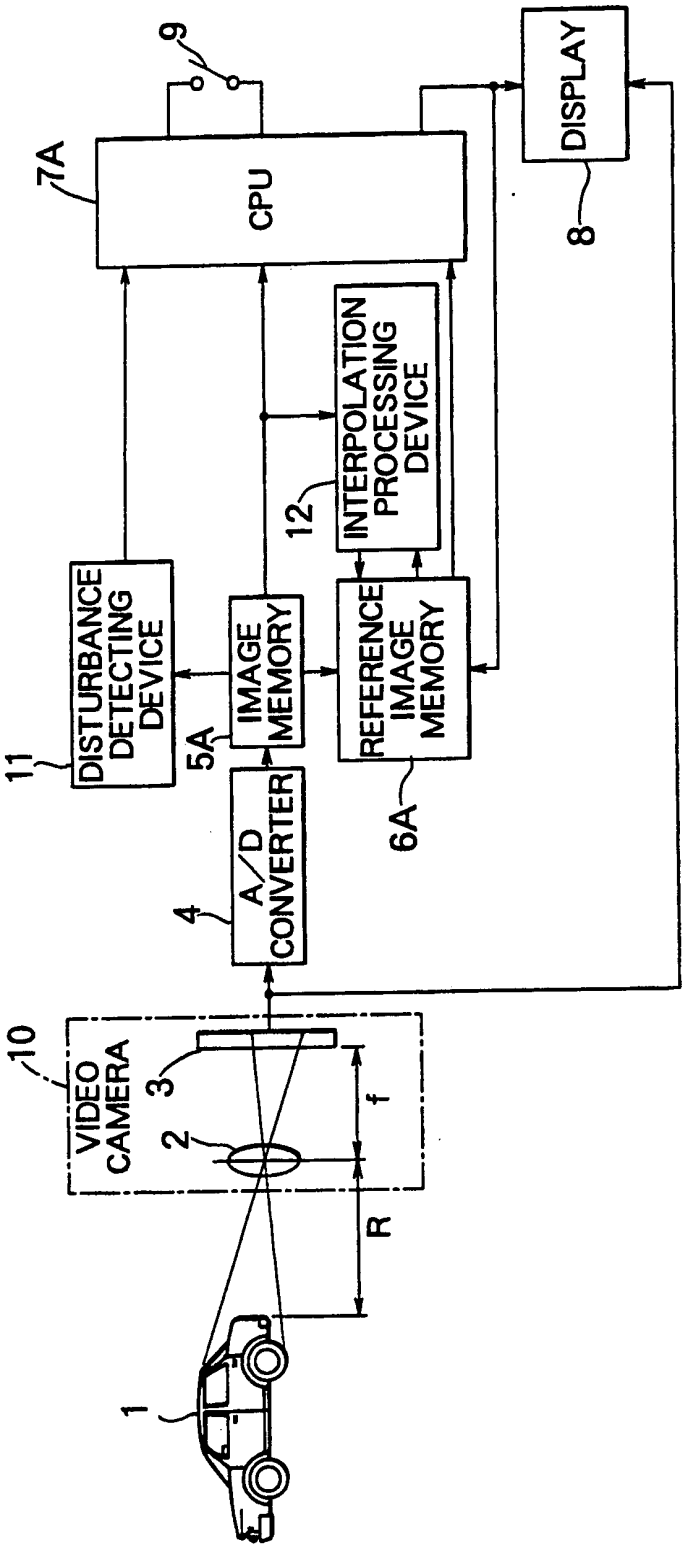
9
7A
CPU
DISPLAY
8
INTERPOLATION PROCESSING DEVICE
12
DISTURBANCE DETECTING DEVICE
11
IMAGE MEMORY
5A
REFERENCE IMAGE MEMORY
6A
A/D CONVERTER
4
VIDEO CAMERA
10
3
2
f
R
1

FIG. 2

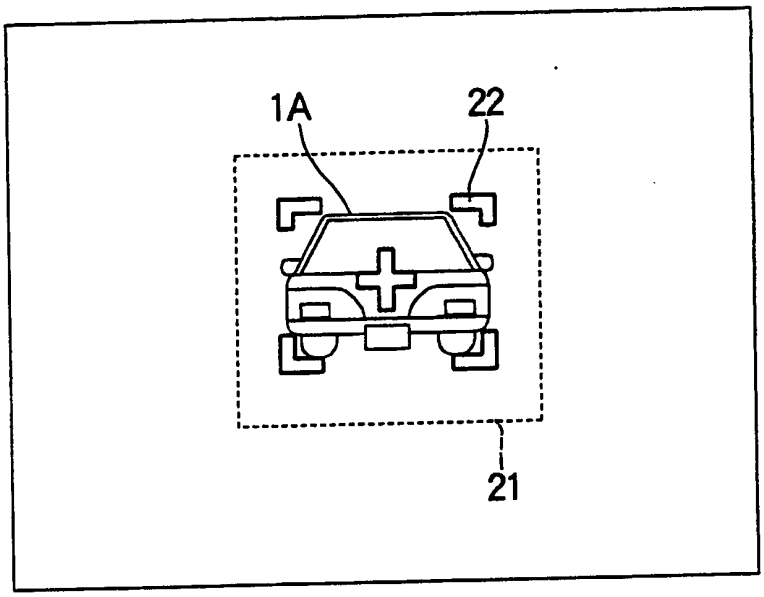

FIG. 3

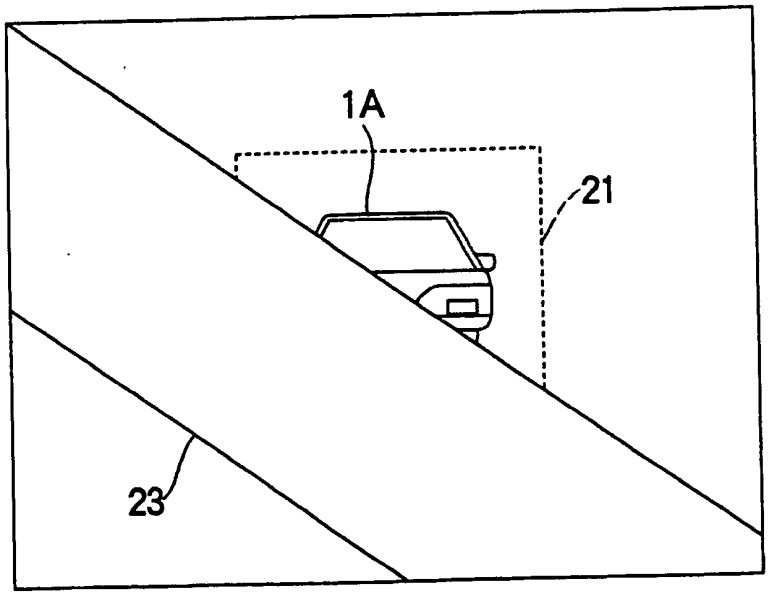

FIG. 4

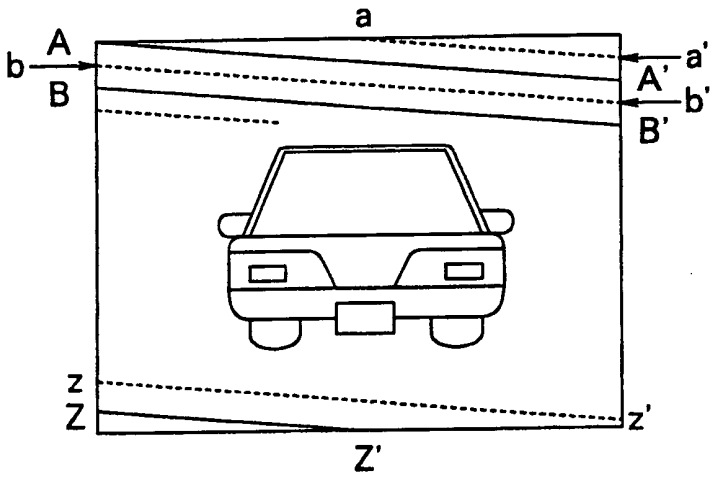

FIG. 5a

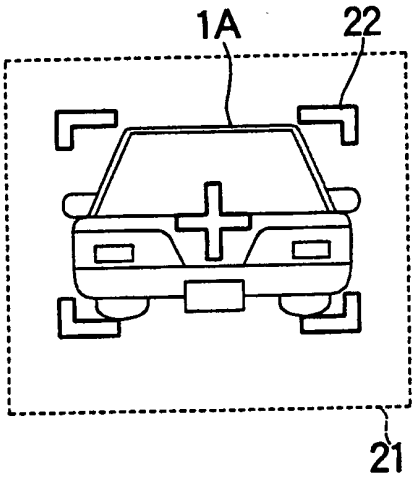

FIG. 5b

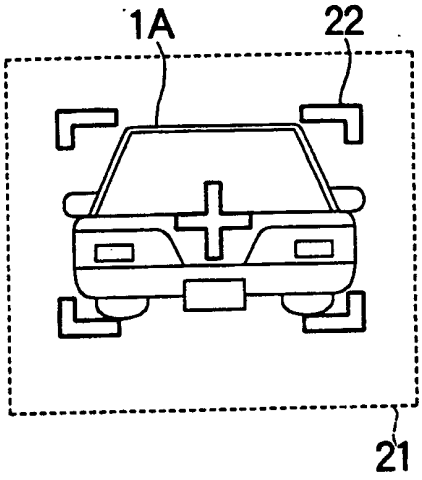

FIG. 6a

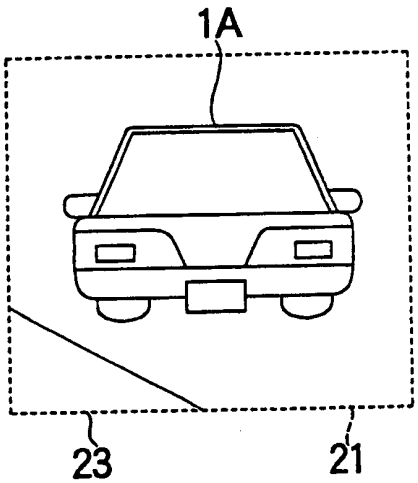

FIG. 6b

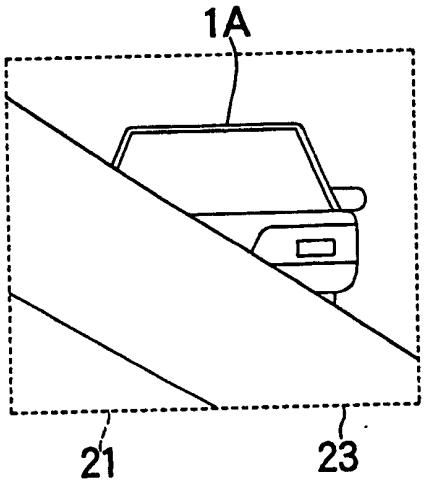

FIG. 7

Ai, j	Ai+1, j	Ai+2, j	Ai+3, j
Bi, j	Bi+1, j	Bi+2, j	Bi+3, j
Ai, j+1	Ai+1, j+1	Ai+2, j+1	Ai+3, j+1
Bi, j+1	Bi+1, j+1	Bi+2, j+1	Bi+3, j+1
Ai, j+2	Ai+1, j+2	Ai+2, j+2	Ai+3, j+2
Bi, j+2	Bi+1, j+2	Bi+2, j+2	Bi+3, j+2

FIG. 8

Ci, j	Ci+1, j	Ci+2, j	Ci+3, j
Di, j	Di+1, j	Di+2, j	Di+3, j
Ci, j+1	Ci+1, j+1	Ci+2, j+1	Ci+3, j+1
Di, j+1	Di+1, j+1	Di+2, j+1	Di+3, j+1
Ci, j+2	Ci+1, j+2	Ci+2, j+2	Ci+3, j+2
Di, j+2	Di+1, j+2	Di+2, j+2	Di+3, j+2

FIG. 9

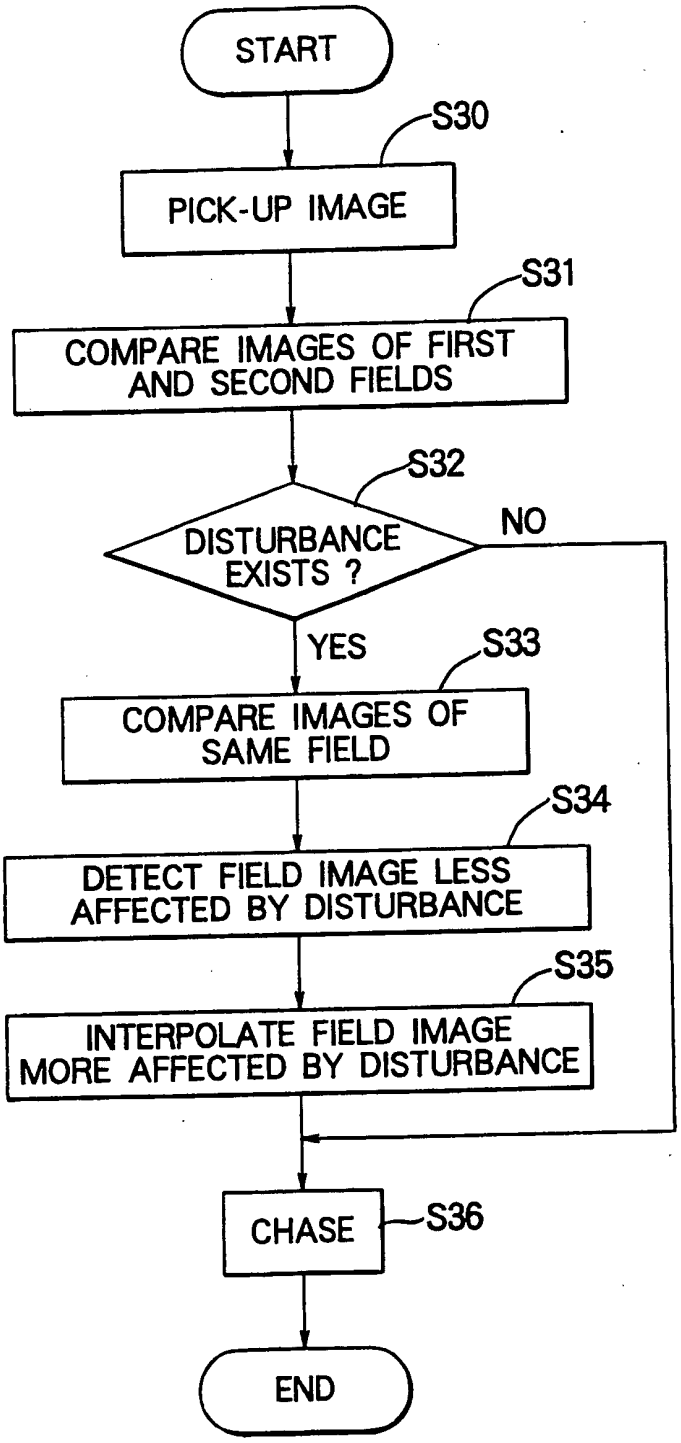
START
S30
PICK-UP IMAGE
S31
COMPARE IMAGES OF FIRST AND SECOND FIELDS
S32
DISTURBANCE EXISTS ?
NO
YES
S33
COMPARE IMAGES OF SAME FIELD
S34
DETECT FIELD IMAGE LESS AFFECTED BY DISTURBANCE
S35
INTERPOLATE FIELD IMAGE MORE AFFECTED BY DISTURBANCE
CHASE
S36
END

FIG. 10

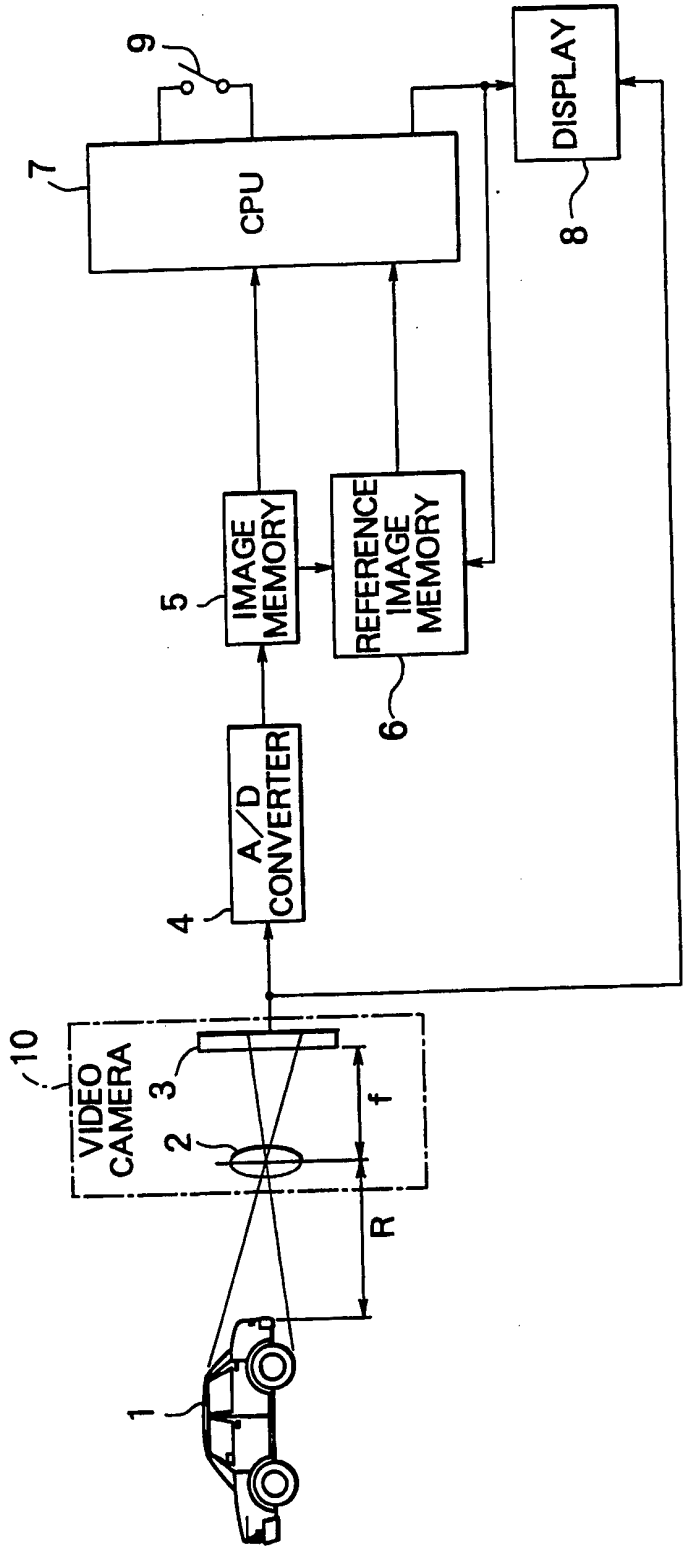
9
7
CPU
DISPLAY
8
5
IMAGE MEMORY
REFERENCE IMAGE MEMORY
6
4
A/D CONVERTER
10
VIDEO CAMERA
3
2
f
R
1

IMAGE CHASING APPARATUS

BACKGROUND OF THE INVENTION

FIELD OF THE INVENTION:

The present invention relates to an image chasing apparatus which is mounted, for example, on a vehicle such as an automobile. More particularly, the invention is concerned with an image chasing apparatus using a video camera and capable of preventing any deviation of a chasing window.

DESCRIPTION OF THE RELATED ART:

An image chasing apparatus has been known which incorporates an image sensor of the type used in video cameras, as disclosed for example in Japanese patent Laid-Open No. 3-197805. Fig. 9 shows, in block diagram, an example of such a known image chasing apparatus. Referring to this Figure, a target vehicle to be chased is denoted by numeral 1. The image chasing apparatus includes a lens 2, an image sensor 3 which is disposed behind the lens 2 at a focal distance f from the lens 2, an A/D converter 4 connected to the image sensor 3, an image memory 5 connected to the A/D converter 4, a reference image memory 6 connected to the memory 5, a computer (CPU) 7 connected to the memories 5, 6, an image display connected to the CPU 7 and also to the image sensor 3, and a switch 9 connected to the CPU 7 and serving as a chasing window setting means.

In the known chasing apparatus having the described construction, the lens 2 and the image sensor 3 form an optical system of a video camera 10. An image of the target vehicle 1, which is at a distance R from the front face of the lens 2, is formed on the image sensor 3 through a lens 2. Image signal produced by the image sensor 3 is converted into digital signal

through the A/D converter 4, and the thus formed digital signals are stored in the memory 5. The chasing window is set by the driver through the switch 9 so that the target vehicle 1 is suitably contained in the area of the window.

In operation, first image signals are stored in the image memory 5 at a moment t0. Then, second image signals are formed by setting a chasing window on the first image signals. The second image signals thus formed are stored in a reference image memory 6. Signals within the chasing window in the second image signals are used as reference image signal. At next moment t1, the first image formed by the first image signals is updated in the image memory 5 and a new window is set by searching an image which is bet correlated with the reference image signals, whereby the chasing window is automatically updated.

This known image chasing apparatus using image sensor, however, suffers from a problem in that the image contrast is impaired due to introduction of external noises produced by wiper system or due to vibration of the vehicle chassis, with the result that the correlation to the reference image is changed or lost, tending to cause a deviation of the chasing window. Consequently, the driver is obliged to frequently reset the window by watching, while driving, the image of the target vehicle 1 on the display 8, thus hampering safety of driving.

SUMMARY OF THE INVENTION

Accordingly, an object of the present invention is to provide an image chasing apparatus in which, once the target vehicle is set, the target vehicle is chased without deviation of the window, thus contributing to safety in the driving.

To this end, according to one aspect of the present invention, there is provided an image chasing apparatus, comprising: imaging means for forming an image of a target to be chased and for producing image signals based on the formed image at a predetermine time interval; a first memory for storing image signals produced by the imaging means; window setting means for setting a chasing window on the image signals which were stored in the first memory a predetermined time before; a second memory for storing, as reference image signals, the image signals on which the chasing window has been set by the window setting means; disturbance detecting means for detecting whether or not any disturbance has been introduced into the image signals stored in the first memory; correcting means for correcting, when the disturbance detecting means has detected that the disturbance has been introduced, the image signals stored in the first memory in such a manner as to reduce the influence of the disturbance; and window updating means which updates the chasing window in accordance with the result of comparison between the reference image signals stored in the second memory and the image signals stored in the first memory when the disturbance detecting means has detected that no disturbance has been introduced, whereas, when the disturbance detecting means has detected that a disturbance has been introduced, updates the chasing window in accordance with the result of comparison between the reference image signals stored in the second memory and the image signals which have been corrected by the correcting means.

According to another aspect of the present invention, there is provided an image chasing apparatus, comprising: imaging means for forming an image of a target to be chased and

for producing image signals based on the formed image at a predetermine time interval; a first memory for storing image signals produced by the imaging means; window setting means for setting a chasing window on the image signals which were stored in the first memory a predetermined time before; a second memory for storing, as reference image signals, the image signals on which the chasing window has been set by the window setting means; window updating means for updating the chasing window in accordance with the result of comparison between the reference image signals stored in the second memory and the image signals stored in the first memory; disturbance detecting means for detecting whether or not a disturbance has been introduced in the image signals stored in the first memory; and update prohibiting means for prohibiting the updating of the window to be performed by the window updating means when introduction of disturbance has been detected by the disturbance detecting means.

BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 is a block diagram of an embodiment of the image chasing apparatus in accordance with the present invention;

Fig. 2 is an illustration of an image in a set window;

Fig. 3 is an illustration of the most-currently input image disturbed by a disturbance;

Fig. 4 is an illustration of one frame of displayed image;

Figs. 5a and 5b are illustrations of first and second fields within the search coverage area for the image shown in Fig. 2;

Figs. 6a and 6b are illustrations of first and second fields within the search coverage area for the image shown in Fig. 3;

Figs. 7 and 8 are pixel-based illustrations of the image signals within the search coverage areas for the images shown in Figs. 2 and 3;

Fig. 9 is a flow chart illustrative of the operation of the first embodiment; and

Fig. 10 is a block diagram of a known image chasing apparatus.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

A description will now be given of embodiments of the present invention, with specific reference to the accompanying drawings.

First Embodiment:

Referring to Fig. 1, a first embodiment of the image chasing apparatus of the present invention is mounted, for example, a vehicle such as an automobile. The apparatus has a video camera 10 and an A/D converter 4 connected to the video camera. The A/D converter 4 is connected to an image memory 5A to which are connected a reference image memory 6A, a CPU 7A, a disturbance detecting device 11 and an interpolation processing device 12. The reference image memory 6A is connected both to the CPU 7A and the interpolation processing device 12. The disturbance detecting device 11 is connected to the CPU 7A. A display 8 is connected to the video camera 10 and the CPU 7A. Numeral 9 denotes a switch which is connected to the CPU 7A and which serves as a chasing window setting means. The video cameral 10 has a lens 2 and an image sensor 3.

A description will now be given of the image chasing process performed by the first embodiment, with reference to a flow chart shown in Fig. 9. In Step S30, image signals are picked up at a predetermined time interval by means of the video camera 10. More specifically, the image of a target vehicle 1 which is ahead of the lens 2 at a distance R therefrom is formed on the image sensor 3 which is disposed behind the lens 2 at the focal distance f of the lens 2, whereby image signals are output from the image sensor 3. The image signals, which are in analog form, are converted into digital signals through the A/D converter 4, and the thus-obtained digital signals are stored in the image memory 5A. The stored image signals are then transferred after elapse of a predetermined time to the reference image memory 6A so as to be stored in the latter.

The driver of the vehicle mounting the first embodiment of the image chasing apparatus operates a switch 9 connected to the CPU 7A, while monitoring the image on the display 8, thereby selecting the image of the target vehicle 1 to be chased. In response to the operation of the switch 9, the CPU 7A functions to set a chasing window on the image signals which are stored in the reference image memory 6A. The selected image with a window 22 set thereon is shown in Fig. 2. Referring to Fig. 2, numeral 1A designates the image of the target vehicle, while 21 indicates the search coverage area over which the image signals are compared later. The chasing window 22 is included within the search coverage area 21.

Fig. 3 shows the most current image which has been newly picked up and stored in the image memory 5A. Part of the image is hidden by a wiper 23 which is produced as a result of introduction of disturbance.

A description will now be given of the image which is picked up by the video camera 10, with specific reference to Fig. 4. A scanning is commenced at a point A on the left upper corner of the display frame along the scan line AA' till a point A' on the right upper corner of the display frame is reached. Then, the next cycle of scanning is commenced from a point B along a scanning line BB' which is parallel to the scanning line AA'. The scanning is cyclically repeated in the described manner along the successive scanning lines down to the scanning line ZZ'. Scanning is thus completed over a predetermined number of scanning lines, e.g., 262.5, and a first field of image frame is formed by the signals obtained through this scanning. Then, scanning is commenced again from a point "a" on the frame along a scanning line aa' which is intermediate between the scanning lines AA' and BB' of the first field. The scanning is then cyclically conducted along successive scanning lines intermediate between the successive scanning lines of the first field, down to the scanning line zz', thus completing scanning over another 262.5 scanning lines. A second field of the image frame is formed by the image signals obtained through this scanning operation. Consequently, image of one frame is formed by two fields, from the signals obtained through scanning along 525 scanning lines in total.

Figs. 5a and 5b in combination show the image within the search coverage area 21 in one image frame shown in Fig. 2. More specifically, Fig. 5a shows the image of the first field, while Fig. 5b shows the image of the second field.

Similarly, Figs. 6a and 6b in combination show the image within the search coverage area 21 in one image frame shown in Fig. 3. More specifically, Fig 6a shows the image of

the first field, while Fig. 6b shows the image of the second field.

Fig. 7 shows, on pixel basis, the image within the search coverage area shown in Fig. 2. Symbol Aij shows the A/D converted value of each pixel in the first field, whereas Bij shows the A/D converted value of each pixel in the second field.

Similarly, Fig. 8 shows, on pixel basis, the image within the search coverage area shown in Fig. 3. Symbol Cij shows the A/D converted value of each pixel in the first field, whereas Dij shows the A/D converted value of each pixel in the second field.

As stated above, image is picked up in Step S30 of the flow shown in Fig. 9. When the pick-up of image is finished, the process proceeds to Step S31 in which the disturbance detection device 11 conducts a comparison between the first field image and the second field image of the most-current image shown in Figs. 6a and 6b, in order to determine whether or not any disturbance has been introduced into the search coverage area 21 of the image of the most-current image signals stored in the image memory 5A. More specifically, the comparison is executed by computing the sum E of the differences between the image signals within the search coverage area of the first field and those within the search coverage area of the second field in accordance with the following formula, and the thus-determined sum E is used as the comparison value indicative of the correlation between the images of two fields.

$$E = \Sigma i \, \Sigma j \mid Ci,j - Di,j \mid \quad \ldots\ldots\ldots\ldots\ldots \quad (1)$$

In Step S32, the disturbance detecting device 11 determines whether or not there is any disturbance, on the basis of the comparison computed value E. More specifically, when the comparison computed value E is greater than a predetermined value E1, the disturbance detecting device 11 determines that there is no correlation between the image of the first field and the image of the second field, i.e., a disturbance exists. Conversely, when the result E of the comparison computation is not greater than 1, the disturbance detecting device determines that a correlation exists between the image of the first field and the image of the second field, i.e., there is no disturbance. When it has been determined in Step S32 that a disturbance has been introduced, the process proceeds to Step S33 in which the CPU 7A performs, using the image within the search coverage area obtained in the preceding image pick-up cycle shown in Fig. 2 as the reference image, a comparison computation for determining the comparison computation value F which is indicative of the correlation between the image of the first field of the reference image shown in Fig. 5a and the image of the first field shown in Fig. 6a which has been influenced by the disturbance. The comparison computation value F is the sum of the differences between the first field of the reference image and the first field of the image within the present search coverage area, and is determined in accordance with the following equation (2) using symbols shown in Figs. 7 and 8.

$$F = \Sigma i \, \Sigma j \, | Ci,j - Di,j | \quad \ldots\ldots\ldots\ldots\ldots \quad (2)$$

A similar comparison is executed between the second

field of the reference image shown in Fig. 5b and the second field of the image affected by the disturbance shown in Fig. 6b, so as to determine the comparison computation value G in accordance with the following equation (3), using symbols shown in Figs. 7 and 8.

$$G = \Sigma i \Sigma j \mid Bi,j - Di,j \mid \quad \ldots\ldots\ldots\ldots\ldots \quad (3)$$

In general, the comparison computation value is smaller when the degree of correlation between the field images is higher. Therefore, in Step S34, the CPU 7A determines that the field images, which provide smaller comparison computation value F or G, have suffered from the influence of the disturbance.

In Step S35, the interpolation processing device 12 performs an interpolation processing in accordance with the instructions given by the CPU 7A, using the images of the field which has been determined in Step S34 as being less affected by the disturbance. For instance, when it has been determined that the image of the first field has been less affected by the disturbance than the image of the second field, image signals for the second field are generated by interpolation based upon the image signals of the first field. The interpolation may be conducted by replacing, on pixel basis, the image signals of the second field with the image signals of the first field, as shown in the following equation (4). In another method of the interpolation, a computation is conducted to determine the average value between the first field image signals of each two adjacent pixels, and the thus determined average value is substituted for the second field image signal, as expressed by

the following equation (5).

$$D_{i,j} = C_{i,j} \text{ or } C_{i+1,j} \quad \ldots\ldots\ldots\ldots\ldots (4)$$

$$D_{i,j} = (C_{i,j} + C_{i+1,j}) / 2 \quad \ldots\ldots\ldots\ldots\ldots (5)$$

Then, in Step S36, the CPU 7A performs chasing of the target vehicle 1 with updated window 22. Namely, when Step S32 has determined that there is a disturbance, the CPU 7A conducts updating of the window 22 by using image signals formed by interpolation conducted in Step S35. Conversely, when it has been determined in Step S32 that there is no disturbance, updating of the window 22 is executed by using the image signal presently stored in the image memory 5A. The updating of the window is conducted in the following manner, as in the case of the known method described before. Namely, the CPU 7A makes a search through the interpolated image signals and the image signals stored in the image memory 5A to find image signals which are most closely correlated to the reference image signals to the reference image signals stored in the reference image memory 6A, and sets a new window based upon the thus found reference image signals. It is thus possible to automatically update the chasing window 22 while suppressing the influence of the disturbance.

Second Embodiment:

In the first embodiment as described, updating of the chasing window 22 is conducted on the basis of the image signals of the field which has been less affected by the disturbance. In contrast, in a second embodiment of the present invention, when the disturbance detecting device 11 has detected an

occasional disturbance, the CPU 7A sets the window 22 at the same position as the previously set window 22, without conducting updating of the window 22 based upon the most current image signals which have been affected by the disturbance. In the second embodiment, updating of the window 22 is prohibited as long as disturbance is being detected by the disturbance detecting device 11. When image signals free from disturbance are detected by the disturbance detecting device, the CPU 7A commences updating of the window 22 using such image signals.

The image signals which are being picked up vary time to time, so that there is a risk that the image signals have been largely varied during a long suspension of updating of the window 22. The arrangement therefore may be such that the chasing operation itself is suspended when the period of suspension of updating of the window 22 has exceeded a predetermined time.

In the second embodiment as described, it is possible to avoid any deviation of the window attributable to occasional disturbance, so that the same advantage is derived as that derived from the first embodiment.

In the illustrated embodiment, setting of the window is conducted manually by the driver through the manipulation of the switch 9. This, however, is only illustrative and the setting of the window may be done in various manners according to the system to which the invention is applied. For instance, it is possible to arrange such that the setting of the window is performed by using a vehicle extracting filter of the type disclosed in Japanese Patent Laid-Open No. 3-45898, or on the basis of the symmetry of vehicle shape as shown in the Journal of Society of Information Processing, Vol. 127, 1986.

WHAT IS CLAIMED IS:

1. An image chasing apparatus, comprising:

imaging means for forming an image of a target to be chased and for producing image signals based on the formed image at a predetermine time interval;

a first memory for storing image signals produced by said imaging means;

window setting means for setting a chasing window on the image signals which were stored in said first memory a predetermined time before;

a second memory for storing, as reference image signals, the image signals on which said chasing window has been set by said window setting means;

disturbance detecting means for detecting whether or not any disturbance has been introduced into the image signals stored in said first memory;

correcting means for correcting, when said disturbance detecting means has detected that the disturbance has been introduced, said image signals stored in said first memory in such a manner as to reduce the influence of said disturbance; and

window updating means which updates said chasing window in accordance with the result of comparison between the reference image signals stored in said second memory and the image signals stored in said first memory when said disturbance detecting means has detected that no disturbance has been introduced, whereas, when said disturbance detecting means has detected that a disturbance has been introduced, updates said chasing window in accordance with the result of comparison

between said reference image signals stored in said second memory and the image signals which have been corrected by said correcting means.

2. An image chasing apparatus according to Claim 1,

wherein aid imaging means produces image signals of one image frame which includes a first field and a second field; and

wherein said disturbance detecting means detects whether or not a disturbance has been introduced, based upon the result of a comparison between the image signals of said first field and the image signals of said second field.

3. An image chasing apparatus according to Claim 2,

wherein said correcting means includes:

field detecting means for detecting image signals of one of said first and second fields which has been less affected by the disturbance; and

interpolation means for interpolating, using the signals of the field which has been detected by said field detecting means as having been less affected by the disturbance, the image signals of the other field.

4. An image chasing apparatus, comprising:

imaging means for forming an image of a target to be chased and for producing image signals based on the formed image at a predetermine time interval;

a first memory for storing image signals produced by said imaging means;

window setting means for setting a chasing window on

the image signals which were stored in said first memory a predetermined time before;

a second memory for storing, as reference image signals, the image signals on which said chasing window has been set by said window setting means;

window updating means for updating the chasing window in accordance with the result of comparison between the reference image signals stored in said second memory and the image signals stored in said first memory;

disturbance detecting means for detecting whether or not a disturbance has been introduced in the image signals stored in said first memory; and

update prohibiting means for prohibiting the updating of said window to be performed by said window updating means when introduction of disturbance has been detected by said disturbance detecting means.

5. An image chasing apparatus according to Claim 4, further comprising: chasing suspension means for suspending he chasing operation when the period of prohibition of updating by said update prohibiting means has exceeded a predetermined time.

6. Image chasing apparatus substantially as herein described with reference to Figures 1 to 9 of the accompanying drawings.

GB 9406140.5

Relevant Technical Fields

(i) UK Cl (Ed.M) H4F (FAAE, FAAP, FAAX)

(ii) Int Cl (Ed.5) H04N (5/232); G06F (15/70)

Search Examiner
J M MCCANN

Date of completion of Search
10 MAY 1994

Databases (see below)
(i) UK Patent Office collections of GB, EP, WO and US patent specifications.

(ii) WPI

Documents considered relevant following a search in respect of Claims :-
1

Categories of documents

X: Document indicating lack of novelty or of inventive step.

Y: Document indicating lack of inventive step if combined with one or more other documents of the same category.

A: Document indicating technological background and/or state of the art.

P: Document published on or after the declared priority date but before the filing date of the present application.

E: Patent document published on or after, but with priority date earlier than, the filing date of the present application.

&: Member of the same patent family; corresponding document.

Category	Identity of document and relevant passages	Relevant to claim(s)
X	EP 0495508 A2 (MITSUBISHI) see Figure 1 and abstract	1

Databases: The UK Patent Office database comprises classified collections of GB, EP, WO and US patent specifications as outlined periodically in the Official Journal (Patents). The on-line databases considered for search are also listed periodically in the Official Journal (Patents).